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FIRST SEMI-ANNUAL PROGRESS REPORT
TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
on Grant NSG 26 004 012
covering the period February 1, 1965 to July 31, 1965

Title of Proposal and Approval Date

The Business and Public Administration Research Center of the University of Missouri proposal to NASA is entitled "Agglomeration Economies in Scientific Research: A Criterion for Allocating Federal Research Expenditures" and was submitted on June 12, 1964. On October 28, 1964, NASA approved the proposal and authorized the initiation of research activities. Because academic activities had already begun for 1964-65 it was not possible to shift the persons who were teaching or engaged in administrative duties immediately to the NASA project, NASA was requested to extend the term of the study to February 1, 1967 and NASA authorized the Research Center to submit semi-annual reports on the research program beginning August 1, 1965. The following report is intended to serve as the "First Progress Report on Grant NSG 26 004 012" and covers research activities from February 1, 1965 to July 31, 1965.

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Overall Objective and Research Strategy of the Project

The overall project objective is the investigation of cost structures in research facilities with a view to establishing cost or efficiency criteria for the spatial allocation of funds for scientific research. In particular the studies in this program are directed toward analyzing the effects of clustering or agglomeration on the cost

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of performing certain kinds of research activities. This involves an improvement in the theory of agglomeration, extending the theory to include research, and the empirical documentation of variations produced in costs (if any) by the presence of other economic or research activity in the same local area.

The research strategy under which the overall project is developing is as follows:

- (1) That basic ancillary activities in support of the program and general preparatory work be completed as early in the sequence as possible.
- (2) That an exploratory (or first generation) study follows. This study is designed to familiarize the project staff with a number of the unique aspects of investigation of research while serving to uncover promising points to sharpen the focus of succeeding analysis. This study should provide an overview of the entire area.
- (3) That, finally, multiple second generation studies which press more intensively the most promising avenues be carried out.

This sequence is heuristic. The initial stages should improve materially the staff's capabilities for dealing with the greater conceptual and empirical difficulties of the second generation studies. The strategy reflects the respect which must be accorded the inherent difficulties of empirical investigation of the economics of research.

Background and Preparation Work

Bibliographic and Source Material: A 116 page bibliography covering the relevant interest areas of this program has been prepared by Professor John Murdock

and Miss Judith Graves. This material is being evaluated by the members of the research staff.

A compendium of the listings of all types of research laboratories has also been developed and the collection of established sources of data pertinent to research is being completed at present. It is anticipated that the compilation of bibliographic and source materials will, following a period of further appraisal and editing, be published.

A self-cumulating file has been established in which comments of other research and other work relevant to the program are made by staff members for use in the study.

Interviews with scientists and engineers in various fields and with a number of research laboratory directors have been conducted. The results have been digested and written up for staff members' reference.

First-generation Study

(This study is presented in rather greater detail than those which follow. It was felt this would be useful because the locational patterns study serves as an introduction to the studies subsequently presented.)

I. The Locational Patterns of Research Activities Study

- A. Investigators: Professor John Murdock and Mr. Anthony Filippello.
- B. Objective and Significance: To distinguish the locational patterns of research by several classifications, including basic and applied, and to determine whether the points of research clustering are reflected in unique cost or budget patterns of the laboratories located at such points. While this is an exploratory study,

designed as a generator of basic data presently unknown, it also will suggest certain guides for evaluating alternative locations for scientific research.

C. Research Design and Procedure:

- (1) Research design is a simple and straight forward cross-section study. A formal model embodies the several hypotheses to be investigated. The structural equations of this model are non-linear in fact although nominally linear in the form in which they appear so that, for example:

$$X_1 = B_1 + B_2 X_2 + B_3 X_3 + \dots + B_n X_n + e$$

where $X_1, X_2, X_3, \dots, X_n$ are variables

$B_1, B_2, B_3, \dots, B_n$ are statistical estimators

e is a random variable

and $X_3 = (X_2)^2$, so that non-linear relations may be

introduced when $B_3 \neq 0$.

This linear equation form is more readily adapted to computer program.

Variables of the model are defined in terms of empirically attainable data. Source materials are both primary and secondary in nature. The primary data are being developed through use of mail questionnaires supplemented by carefully restricted interviews. Sampling is used in the acquisition of all data.

The sample design is perhaps the most complex element in the overall research approach. A summary of the sampling procedure is included at the end of this section for general reference. The particular design was adopted on efficiency grounds. It

permits us to generate all data necessary for the testing of all hypotheses with a single data collecting effort of minimal size.

Statistical analysis will utilize multiple regression analysis primarily and, to a more limited extent, analysis of variance techniques. Results will, of course, be subjected to appropriate statistical tests.

It should also be mentioned that the elemental unit of this study is the research laboratory. This appears to be clearly superior as an indicator of systematic research activity to patents or other previously employed indicators.

Summary of Sample Design for Location Patterns of Research Activities Study

The population to be sampled consists of industrial research laboratories in the United States. These will be divided into groups of laboratory research subjects in the mutually exclusive scientific classifications of (1) Life Sciences, (2) Chemistry, (3) Physics and Related Engineering, and (4) Other, a classification containing those subjects of research which cannot be classified with any one scientific category. The four groups exhaust the population of laboratories. Each of these groups is sub-divided by specific subject of research interest and these specific research subjects are grouped as to the number of laboratories researching the specific research subject. There are five of these "number of laboratories in subject" cross-classifications; under 5, 5-19, 20-49, 50-100, and over 100. Hence, we have twenty mutually exclusive and exhaustive cross-classified sets of research subjects.

The sample design utilizes proportionate stratified, cluster, and simple random sampling principles. The goal is to sample from the population in such a way that we will be able to draw inferences about laboratory research activity as a whole in the United States, and about the basic categories of scientific research activity and "size" of research subject area separately.

The proportion which each cross-classification makes up of the universe is determined so that a two-stage proportionate

stratified sample may be taken of research subjects. In so doing we minimize the variance of the sample while letting each stratum carry its proper relative weight. Within each stratum a cluster sample is taken of research subjects. This is done in order to cut down the amount of time-consuming paper work which would be prohibitive in a simple random sample of research laboratories within each stratum. Cluster sampling also permits the testing of research subjects within a stratum by analysis of variance techniques for homogeneity of research subjects classified together.

A simple random sample is then taken from each of the selected research subjects as the final observations. A constant sampling fraction is used throughout the entire final stage of the sample to insure that the proportionality of all strata and included subjects is maintained.

The final sample is one from which probability statements about industrial research laboratories in general may be made. Similarly, statements about any classification or cross-classification may be made, either separately, or in sub-groups. The design of this sample also lends itself to analysis of variance testing of possible differences within and between the different strata or sub-groups of strata.

D. Special problems faced by this Study:

This first-generation study was specifically selected to minimize the number of special problems with which it would have to contend. There are, nevertheless, some unavoidable problems largely associated with the heterogeneity of research and research activities. The distinction between "basic" and "applied" research, for example, is difficult to draw in a manner that conveys unambiguous meaning to respondents of our surveys. We believe that this particular problem has been solved. Design of the mail questionnaire included a number of similar difficulties. Furthermore, our pre-test questionnaire responses show omissions. These problems are, however, typical of empirical studies and probably do not

merit being called special.

In summary, while there are some problems associated with this study, some of which are special in the sense that they are aggravated by the non-standard nature of the research activity, we do not foresee any problems which should bar or materially delay reasonably steady progress on this study.

E. Sequence of Study:

- (1) The development of hypotheses;
- (2) Establishment of definitions and assumptions and subsequent development of analytical model;
- (3) Determination of the sources of data, methods required for collection of primary data, and tools to be utilized for data analysis;
- (4) Pre-testing of each element in steps (1) through (3), critique and modifications as necessary;
- (5) Pilot study consisting of actual collection, processing, and evaluation of data: critique of pilot study with any further modifications;
- (6) Collection, processing and evaluation of data for the study;
- (7) Synthesis and writing up of results of the study.

F. Study Calendar:

We are presently completing step (4) and have begun step (5) in the above Project Sequence. Step (6) is scheduled to be completed in mid-November with step (7) completed by year end. This should permit a final report of this first stage project on or before the time of the second progress report.

The Second-generation Studies

Several second-generation studies follow rather closely from the study described above. Two of these are underway and are described below. Experience already obtained from the first-generation study is being made available to the investigators involved in these studies and this procedure will continue through the completion of the first-generation study.

II. The Location Sequence of Research and Industry Study

- A. Investigators: Professor John Murdock, Mr. Anthony Filippello, and Miss Judith Graves.
- B. Objective of the study: The study is a direct extension of the first-generation study and its objective is basically the same. However, it seeks to establish the sequence of development of research activity and industry in certain locational patterns. The possible policy implications of this study are far-reaching. The study should provide clearer indication of cause and effect relations between research activities at particular types of locations to other kinds of economic activity in the same area. And it is designed to discern differences between basic and applied research in this respect.
- C. Research Design: This study again follows that of the first-generation study in general form. The important distinction is that this study includes time series with lagged variables for purposes of determining the sequential patterns of agglomeration and the certain cost or budget patterns associated with these agglomerations.

- D. Data Sources are modified from the first-generation study only in that this study requires data for several rather than a single point in time. Some of the required data from primary sources have been subjected to pre-tests with results that warrant further experimentation with this type approach.
- E. Calendar: Dates for preliminary drafts and final reports are tentatively expected in the summer and fall, 1966.

III. Cost Analyses of Agglomeration Patterns Study

- A. Principal Investigator: Professor John C. Murdock
Staff: Professors Donald Murry, John M. Brazzel, Carmen Menezes,
Nicholas Filippello and Miss Judith Graves
- B. Objective and Significance of Study: The aim of this study is to provide more intensive and more penetrating analysis of the behavior of the costs of performing research activity as it is affected by patterns of agglomeration of economic activity generally and of research agglomeration in particular. As with the overall research program, the significance of such a study is to provide an efficiency criterion for the spatial allocation of research funds. The study seeks to identify particular sources of agglomeration economies and to establish the magnitude of their influence.
- C. Research Procedures: Following R. R. Nelson and others it has been decided that the optimizing strategy is to pursue multiple approaches in view of the general lack of empirical support from earlier work and the inadequacy

and contradictory nature of theoretical treatments of agglomeration economies and diseconomies. Hence, while the general preparatory work for this study has been developed along common lines, the approach is a cross-sectional survey while the other is case study. It is anticipated that this redundancy of approaches will continue only so long as each gives promise of providing significant results unattainable or less efficiently attainable by the alternative approach.

- D. Current Status and Calendar: Preparatory work on the study is not yet completed. However, the development of a formal model to be used with the case study approach is largely completed and the process of selection of specific research clusters for study are underway. The cross-section approach is more heavily dependent upon the results of the first-generation study and will build more directly from it. Data sources are being currently developed for those aspects of the study that reach beyond that utilized by the first-generation study. These studies should be in the data collection stage during the fall and winter with evaluation of material in the spring and summer of 1966. The preliminary drafts are scheduled for the fall of 1966 with final reports in January, 1967.

Budget Estimates for Projects Under Grant

Under the grant approved by NASA a sum of \$175,926 was allocated for the

research program described in the Research Center proposal. This amount was budgeted over a two-year period beginning February 1, 1965 and ending January 31, 1967. The following estimates have been prepared to provide NASA with an indication of costs that are presently anticipated from February 1, 1965 to July 31, 1965 and from August 1, 1965 to January 31, 1966. These estimates cover the first half of the program life.

<u>Item Description</u>	<u>Feb.-July 1965</u>	<u>Aug. 1965-Jan. 1966</u>
Administration (Paterson)	\$2,700	\$3,000
Secretarial (Stone, Zumbel)	500	2,100
Travel (Paterson, Murdock Murry)	600	--
Travel (Paterson, Murdock, Murry, Brazzel, Menezes)	<u>--</u>	<u>3,000</u>
Totals	\$3,800	\$8,100

Substantive Research Projects:

I. Location Patterns of Research Activities Study

Murdock (Investigator)	\$3,034	\$2,334
Filippello (Assistant)	1,300	467
Supplies and Materials	100	200
Consultants	<u>400</u>	<u>1,200</u>
Totals	\$4,834	\$4,201

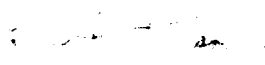
	<u>Feb.-July 1965</u>	<u>Aug. 1965-Jan. 1966</u>
II. Location Sequence of Research and Industry Study		
Murdock (Investigator)	\$3,034	\$2,334
Filippello (Assistant)	960	467
Graves (Assistant)	1,300	934
Supplies and Materials	75	150
Consultants	<u>--</u>	<u>500</u>
Totals	\$5,369	\$4,385
III. Cost Analyses of Agglomeration Patterns Study		
Murdock (Project Director)	\$3,034	\$2,334
Murry (Investigator)	6,880	5,000
Brazzel (Investigator)	2,400 (Summer salary chargeable to Research Center)	6,000
Menezes (Investigator)	--	6,000
Filippello (Assistant)	--	467
Graves (Assistant)	960	467
4 Research Assistants	--	5,600
Supplies and Materials	--	350
Consultants	<u>--</u>	<u>800</u>
Totals	\$10,874	\$27,018

	<u>Feb.-July 1965</u>	<u>Aug. 1965-Jan. 1966</u>
<u>Project Totals</u>		
Administration, etc.	\$ 3,800	\$ 8,100
Project I	4,834	4,201
Project II	5,369	4,385
Project III	<u>10,874</u>	<u>27,018</u>
Totals	\$24,877	\$43,704

The above estimates do not include DASI or overhead contributions which were incorporated in the final program proposal submitted to NASA. These estimates are intended to provide NASA with a view of project costs as these are related to detailed plans submitted in the body of this First Semi-Annual Progress Report.

We shall, of course, continue to supply NASA with semi-annual reports as well as submit supplemental information requested. In addition, as the research progresses we shall apprise NASA of new projects that seem likely to provide insights into the effect of NASA programs upon local, regional and national economies.

Respectfully,


Robert W. Paterson
NASA Program Director and Director
Research Center

BIOGRAPHICAL DATA ON FACULTY RESEARCH STAFF

Biographical data about staff members of the Research Center and School of Business and Public Administration who have participated in the development and pursuit of the project studies included in this report are described below. Each of these individuals is substantially involved in one or more of the described proposals. In addition, there are individuals in physical and social science departments of the University not directly associated with the School of Business and Public Administration who are available as participants or consultants. Biographical data for the Research Assistants, mentioned in some aspects of the project description, have not been included below.

The staff listed on the following pages forms the nucleus of the research group that has undertaken the major portion of work included in this report. In addition, the Center employs reputable scholars at other universities during summer periods and brings in consultants from business, industry, government, and academic life as the need arises.

BRAZZEL, J.M., Assistant Professor of Economics and Faculty Research Assistant. EDUC: Texas A & M University, B.A. and B.B.A., 1960. Tulane University, Ph.D. requirements to be completed in November 1965. EXPERIENCE: Graduate Teaching Assistant, Department of Economics, Tulane University, 1961-62. Public Affairs Research Assistant, Department of Economics, Tulane University, 1962. Instructor of Economics, U.S. Air Force Academy, 1963-65. BIBLIOGRAPHY (Dissertation): "Economic Effects of a New Firm on a Local Economy: A Conceptual Study of Alternative Models."

MENEZES, C.F., Assistant Professor of Economics and Faculty Research Assistant. EDUC: University of Bombay, B.A. (Hons.), 1958; Marquette University, M.A., 1960, economics; Northwestern University, 1961 - (Expect to receive Ph.D. in June, 1966). EXPERIENCE: Research Assistant, Department of Economics, Marquette University, 1959-60; Research Assistant, "Economic Survey of

Liberia," Northwestern University, 1961-62; Research Assistant, Transportation Center at Northwestern University, 1963-65. BIBLIOGRAPHY: "World Trade in Iron Ores," paper in Economic Survey of Liberia, Northwestern University Press, 1963; (with H.F. Williamson and R.E. Andeano) "The American Petroleum Industry," paper in a forthcoming volume of the National Bureau of Economic Research; (with Beals, Moses, Levy and Greenwood) Ph.D. dissertation to be part of a forthcoming book: Migration, Transport Investment and Economic Growth, this study is being conducted at the Transportation Center, Northwestern University, under a grant from the Brookings Institution.

MURDOCK, J.C., Professor of Economics. EDUC: University of Wisconsin, Ph.D., 1955. EXPERIENCE (Teaching): Professor of Economics, Department of Economics, University of Missouri, 1958-present; Instructor, Assistant Professor, Associate Professor, Department of Economics, University of Missouri, 1951-58. EXPERIENCE (Other): Chairman, Department of Economics, University of Missouri, 1962-64. BIBLIOGRAPHY (Articles): "The New Economics," Encyclopedia Americana, 1953, 1955; "A History of Missouri Banking," Mid-Continent Banker, 1954; "Diminishing Returns in the Depletion of Mines," Land Economics, No. 4, 1956; "The Structure of Metropolitan Areas," University of Missouri, Business and Government Review, November-December, 1960; "Higher Education in Missouri: The Coming Impact on State Finances," University of Missouri, Business and Government Review, March-April, 1962 (with John Rapp); "Homer Hoyt and Dilemma of Urban Economic Base Theory," Land Economics, No. 1, 1962; "A Theory of Urban Economic Organization," in Approaches to the Study of Urbanization, Ed. by R.L. Stauber, University of Kansas Press, Lawrence, Kansas, 1964. WORK IN PROGRESS: Structure Analysis of the St. Louis and Kansas City Metropolitan Economies (Monograph in the Missouri Economy Study Series, 1965.

MURRY, D.A., Assistant Professor of Economics, University of Missouri, St. Louis, Research Assistant, Research Center (September 1964). EDUC: University of Missouri, M.A., 1961; Ph.D. dissertation in progress. EXPERIENCE (Teaching): Teaching Assistant and Instructor, University of Missouri, 1960-62. Instructor 1964-65, University of Missouri (St. Louis), Assistant Professor, 1965, University of Missouri (St. Louis). EXPERIENCE (Other): International Business Machines, Summer Intern, 1960; Bureau of International Commerce, Department of Commerce, Summer Intern, 1961. WORK IN PROGRESS: Dissertation - A Theoretical Analysis of Indivisibilities and Agglomeration. An Analysis of the Growth Potential of Research and Development in Missouri (Missouri Economy Study).

PATERSON, R.W., Professor of Business Research, Director of Research Center. EDUC: University of Virginia, Ph.D., 1953. EXPERIENCE (Teaching): Professor of Business

Research, School of Business and Public Administration, University of Missouri, 1959-present; Professor of Economics, University of South Carolina, 1953-59; Instructor, University of Virginia, 1944; 1949-53. EXPERIENCE (Other): Director, School of Business and Public Administration, Research Center, University of Missouri, 1959-present; Director, Bureau of Business Research, University of South Carolina, 1953-59; Research Associate, University of Virginia, 1949-53; Officer in Foreign Service, U.S. Department of State, 1945-49; Consultant, Cresap, McCormick and Paget, on studies conducted 1956, 1957, 1960, and 1961. BIBLIOGRAPHY (Books): Robert W. Paterson and Olin S. Pugh, Report of the Corporate Tax Study Committee of the State of South Carolina, 81 pp., January 14, 1958; The Carolina Economy, University of South Carolina, Bureau of Business and Economic Research, July 15, 1958, 54 pp.; Contributor and editor of Financing Missouri's Road Needs (Bureau of Business and Economic Research, University of Missouri, January 1961), 212 pp.; Missouri General Fund Trends and Projections of Revenues and Expenditures, Robert W. Paterson, Donald S. Holm, Jr., Paul E. Junk, and Vincent Tyndall, University of Missouri, Research Center, September 1962, 44 pp.. BIBLIOGRAPHY (Articles): "Post-War Plans for the Returning Veteran," University of Virginia, News Letter, Vol. XXI, No. 11, March 1, 1945; "Why Industry Moves to the Southland," University of South Carolina, Business and Economic Review, Vol. 1, No. 4, April 1, 1954; "Rural-Urban Population Changes," University of South Carolina, Business and Economic Review, Vol. 1, No. 6, June 1, 1954; "South Carolina's Manufacturing Growth," University of South Carolina, Business and Economic Review, Vol. 1, No. 8, November 1, 1954; "Industrial Location Incentives," Southern Industrial Development Council, Proceedings of the 10th Annual Meeting of the Southern Industrial Development Council, New Orleans Chamber of Commerce, November, 1954; "The Business Outlook-1956," University of South Carolina, Business and Economic Review, Vol. III, No. 1, January 1956; "The 1957 Business Outlook," University of South Carolina, Business and Economic Review, Vol. IV, No. 1, January 1957; "Proceedings of 10th Educators Conference," Standard Oil Company of New Jersey, 30 Rockefeller Plaza, New York City, published November 1957; "The United States Economy in 1958," University of South Carolina, Business and Economic Review, Vol. V, No. 1, January 1958; "The 1959 Business Outlook - State and Nation," University of South Carolina, Business and Economic Review, Vol. VI, No. 1, January 1959; "Business Forecast for 1960," University of Missouri Business and Economic Review, Vol. 1, No. 1, January-February 1960; "The U.S. Economy in 1961," University of Missouri Business and Economic Review, Vol. II, No. 1, January-February 1961; "Industrial Development for What," Missouri Business, June 1961, pp. 12-14; "Economic Aid for Less Developed Nations," University of Missouri Business and Government Review, Vol. II, No. 5, September-October 1961; "The 1962 Business Outlook," University of Missouri Business and Government Review, Vol. III, No. 1, January-February 1962; Planning in Highway Administration, Proceedings of a Conference on Planning in Highway Administration, National Academy of Sciences, Highway Research Board, Special Report 72, March 27, 1962, Washington, D.C.; "The 1963 Business Outlook," University of Missouri Business and Government Review, Vol. IV, No. 1, January-

February 1963; "B&PA Research Center: Academic Arm in Study of Tomorrow's Problems Today," University of Missouri Review, Semi-Annual April 1963; "Highway Needs and Finance in Missouri," Traffic Quarterly, July 1963, 10 pp. WORK IN PROGRESS: Evaluation of Economic Forecasting Techniques; under 2 year contract with U.S. Bureau of Public Roads; Development of Federal Economic Policy; a 4 year study of major changes in the direction of Federal legislation affecting the economy of the U.S..

All staff members have considerable research experience of the kind desirable for the projects included in this proposal.

The personnel for the study projects are available, and we are in a position to continue research work on the projects indicated.

Not included on the biographical list are those graduate students who are assisting professional staff members with the studies. These assistants, however, have been specifically selected for special skills or with special backgrounds to enable them to make unique contributions to the projects in which they are participating. These include statistics, accounting, mathematics, and library training or special experience.

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